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This paper applies a comparative institutional perspective to the organizational design called matrix structure. After discussing the motivations for a multidimensional form of organization, the paper compares the transaction cost characteristics of the matrix (MX-form) structure with those of the well-known multidivisional (M-form) structure. This analysis reveals three advantages and three disadvantages of the matrix structure as well as two conditions affecting the efficacy of a matrix. Examples from multinational corporations are used throughout the paper to illustrate the analysis.

INTRODUCTION

Organizational innovation, which refers to the development of new and possibly more efficient forms of economic organization, has been recognized as a fundamental driver of economic progress (Arrow 1971, Chandler 1977, Williamson 1975, 1985). The most celebrated success in organizational innovation may be the multidivisional (M-form) structure, whereby a firm is organized into quasi-autonomous divisions responsible for operational decisions, thus allowing its top executives to concentrate on strategic decisions (Chandler 1966). The M-form structure is considered to possess many advantages in transaction cost economizing over its predecessor, the function-based unitary (U-form) structure, and to have made the development of large diversified modern corporations an economic possibility (Williamson 1975: 136-141).

In the last two decades, many large corporations have experimented with a newer and even more complex organizational design called the matrix. A matrix essentially combines two or more layers of M-form structures. The implementation of the matrix structure in multinational corporations (MNCs), for instance, typically has two overlapping layers of organizational units: the product divisions and the geographic-area divisions. A product division is held responsible for one set of products on a global basis, and an area division is held responsible for the all operations within its geographic segment of the world. For example, a firm's operation in a specific country (e.g., Singapore) formally reports to an area command center (e.g., the Asian Regional Headquarters) as well as reporting to one or more product-based command centers (e.g., the Consumer Product Division and the Industrial Product Division). A diagrammatic illustration of the matrix structure appears in Figure 1.

Unlike the early experiments with the M-form structure, which turned out to be generally successful (Chandler 1966, Teece 1981), the more recent experiments with the matrix structure

have produced mixed results (Daniels *et al.* 1984, Egelhoff 1982, Pitts and Daniels 1984). While some companies (e.g., ABB and 3M) attribute their successes partially to their matrix structures (Agres 1991, Anderson 1994, Hammerly 1992), other companies (e.g., Texas Instruments and Xerox) have largely abandoned the matrix structure that they had adopted earlier (Larson and Gobeli 1987). Large-scale surveys found a matrix form being used by 28% of major U.S. or European multinational companies, by 43% of R&D projects, and by 27% of hospitals (Burns and Wholey 1993, Egelhoff 1988, Katz and Allen, 1985). In their extensive study of the organization of U.S. hospitals, Burns and Wholey (1993) reported that 28% of those that had earlier adopted a matrix structure later abandoned it. Even though the matrix form of organization has been subject to considerable debate among organization theorists and practitioners (Bartlett and Ghosal 1990, Davis and Lawrence 1977, Ford and Randolph 1992), it has received limited attention from academic economists. As a result, many questions about its economic properties have been left largely unanswered. For instance, does the matrix structure economize on intrafirm transaction costs the same way as the basic M-form structure? If not, how do its transaction cost properties differ from those of the basic M-form structure? Are there any conditions that make the matrix structure economically superior/inferior to the M-form structure? And more generally, does the matrix represent another major advance in organization design or just a failed attempt at organizational innovation? Our paper raises, and searches for answers to, these questions.

The paper is organized as follows. The next section explores the reasons that firms may find the unidimensional M-form structure constraining and desire to shift to a matrix structure, which we shall designate as the MX-form.¹ The third section examines in detail the advantages and disadvantages of this organizational form in dealing with various costs of intrafirm

transactions. The fourth section derives the conditions under which the MX-form is likely to be economically superior to the conventional M-form and provides a case that illustrates these contingency ideas. The fifth section summarizes and concludes the paper.

* * Insert Figure 1 about here * *

MOTIVATIONS FOR A MULTIDIMENSIONAL STRUCTURE

As explained by Chandler (1966: 282-283) and Williamson (1970: 120-121), a necessary condition for the unidimensional M-form structure to be economically efficient is that the firm can be organized into a number of essentially self-contained operating divisions or quasi-firms. This is arguably the most critical condition that enables the M-form structure to economize on intrafirm transaction costs.

Significance of Divisional Autonomy

We briefly review four reasons for divisional autonomy before exploring needs to deviate from essentially self-contained divisions. First, when each division is essentially self-contained, most of its operational decisions should have little or no impact on other divisions. If there exist a small number of decisions that do have a significant impact on other divisions, those decisions can be coordinated by the corporate headquarters (HQ) without the danger of overburdening its capacity, given the infrequency of their occurrence. This serves to save on both the costs of inter-divisional bargaining and the costs of suboptimal compromises that are likely to arise if the various divisions are highly dependent on one another and frequently forced to negotiate the needed coordination by themselves (Milgrom and Roberts 1988).

Second, a high degree of operational autonomy also ensures that a division's operating results (such as profit, production costs and sales revenues) are relatively good measures of its

managers' performance. One of the key functions of the general management at the corporate headquarters is to provide the right performance incentives for the divisional managers, and distorted performance measures can weaken or even pervert their incentives (Stiglitz 1989). Broadly speaking, one may measure the performance of managers by looking at their behaviors (i.e., inputs) and their achievements (i.e., outputs) (Calfee and Rubin 1993, Hennart 1993). The input-oriented measures tend to engender significant errors due to the imperfect observability and imperfect verifiability of managerial behavior (Holmstrom 1982). For instance, how much care a manager took in choosing a new vendor is likely difficult for others to observe; although it may be easy to find out the alternative selected, considerable ambiguity can still exist as to whether that choice was the optimal one at the time of the decision. The output-oriented measures may or may not accurately reflect a manager's performance depending on whether the business unit the manager administers is also influenced by factors beyond his/her control, such as the actions of those from other business units (Barzel 1989). The relative autonomy of each division, therefore, serves to preserve the quality of the output-oriented performance measures and save on the costs of monitoring and incentive provision.

Third, the organization of the firm into essentially self-contained divisions also permits the decentralization of the more specialized operational decisions to the divisional level and thus reduces what is known as influence costs. As suggested by Milgrom (1988), the decisions of executives tend to affect the interests of subordinates who are often the suppliers of information needed for making those decisions; so lower-level managers frequently spend time and effort lobbying their superiors. The costs of such influence activities to the organization include not only wasted executive time but also degradation of some managerial decisions due to lobbying

by self-interested parties. The extent of lobbying activities in a firm, and their associated costs to the firm, can be expected to decrease as decision making is more decentralized.

Fourth, the lack of inter-divisional dependence in day-to-day operations serves to free the corporate HQ from operational matters and enable it to focus on the more important task of exploiting the strategic synergy among the various parts of the firm (Chandler 1966). It should be noted that the relative autonomy of the divisions at the operational level does not signify the absence of strategic interdependence. As explained by Williamson (1975), it is precisely the presence of strategic synergy among the various divisions that makes the whole of the firm larger than its parts and provides the motivation for economizing on the bounded rationality of the corporate HQ's senior executives.

Multidimensional Interdependence

As emphasized in the above discussion, the economic advantage of the unidimensional M-form structure depends crucially on the extent to which the operations of the divisions that the firm set up are self-contained. Although there have always been firms that can not be efficiently organized into autonomous divisions, a growing number of firms have in recent years found that their continued expansion is making it increasingly difficult to maintain the autonomy of their operating divisions (Bartlett and Ghoshal 1989). In the rest of this section, we will explore how the expansion of some firms diminishes the economic feasibility of organizing themselves into largely self-contained divisions and prompts them to shift to a matrix structure.² Our exposition will use the organization of multinational corporations (MNCs) as an illustration, but our basic analysis applies equally to firms that do business in only one country, as will be discussed later.

Many of today's MNCs, especially those that initially started in the United States, had already grown quite large under a unidimensional M-form structure before they undertook much

international production (Egelhoff 1988, Stopford and Wells 1972). Their operating divisions, organized along product lines, were typically set up to be largely self-contained business units. When they began to expand into overseas production, however, they often found it more efficient for a number of reasons to set up a single national subsidiary to manage operations that were under the control of different product divisions in their home country. First, being foreign, a company may be unable to deal effectively with local governments and labor unions if it is organized as several largely autonomous units without unified representation (Bartlett 1982). In addition, the operations of different product divisions may have many common suppliers or customers in a given country; coordination in procurement and customer service can thus yield significant economic benefits (Mascarenhas 1984). Moreover, the company's local market may be much smaller than its home market, so that economies of scale may dictate that the operations of two or more divisions share some of the same manufacturing processes, such as a foundry. Hence, as a firm expands into international production, potentially large benefits may arise from efforts in coordinating its activities in different product lines within the same geographic area.

In the meantime, the establishment of production subsidiaries in multiple countries also tends to raise the need for coordination across geographical areas concerning the same product line. When a company manufactures the same product in several countries, two or more of its subsidiaries may become interested in selling to a country or region where the company does not yet have any operation. Inter-subsidiary conflicts of this type can cost the company in terms of sales and profit (Doz and Prahalad 1984). Also, the company's various subsidiaries are unlikely to improve their product design and production efficiency at the same pace; so there are likely gains from inter-subsidiary technology exchanges, which the potentially competing units may not undertake on their own (Flaherty 1986).

An Organizational Dilemma

When there exist large benefits from coordination along both of the dimensions discussed above, it becomes difficult to organize an MNC into essentially self-contained divisions because much inter-divisional dependency still remains whether the divisionalization is based on product lines or geographical areas. If the company adopts a unidimensional structure along one of these dimensions, it is likely to face difficulties in coordination along the other dimension.

Intrafirm coordination in general can be performed in either of two ways (Rubin 1990). One way allows the coordinative decisions to be made by a centralized authority that oversees all the administrative units among which coordination is desired. The other way allows those administrative units to coordinate among themselves with no intervention from a centralized authority. When an MNC is divisionalized along a single dimension (i.e., product or geography), coordination along the other dimension is likely to engender serious transaction cost problems no matter which method of coordination the firm adopts (Rugman and Verbeke 1992).

Suppose for the moment that a firm is divisionalized along product lines and several of its product divisions have operations in a particular country. Under this structure, the only common authority over the country units of those product divisions is the senior management at the firm's corporate HQ. Coordination through administrative fiat is bound to be expensive because information has to travel through several layers of the hierarchy all the way to the top, costing much executive time and likely distortion in communication (Stiglitz 1989). When the frequency of such coordination is high, the corporate HQ's senior management could be overburdened by operational decisions and distracted from the more important strategic decisions. In addition, centralization of many operational decisions could also cause a rise in lobbying activities within the firm and in their associated costs (Milgrom 1988). Although the senior executives could

reduce their time spent reviewing such decisions by establishing decisions rules for lower-level managers to follow, governing by rules can adversely reduce managerial flexibility and dampen individual initiatives (Milgrom and Roberts 1988).

The alternative to such a product-division structure involves leaving the coordinating decisions to the country managers of the relevant divisions. But the lack of a common boss for the country managers of different product divisions probably subjects their joint decision making to excessive bargaining and suboptimal compromises (Holmstrom and Milgrom 1990). Because their rewards are based on the results of their own divisions, they feel motivated to promote the interests of their own divisions when inter-divisional conflicts arise (such as in deciding how to satisfy the export ratio imposed by the host government on the company as a whole). Not only may the decision process involve costly inter-divisional bargaining, but the final decision reached may represent a suboptimal compromise and face further implementation difficulties. Although the company can create some staff positions for each country to coordinate the activities of the different product divisions, their lack of line authority tends to render them ineffective in influencing the decisions of the product managers (Bartlett 1982).³ In addition, their limited authority over the company's operations in the country also makes any available output indicators poor measures of their performance, thus leading to weakened performance incentives for these staff managers (Ouchi 1977).

Although the above problems with intra-area coordination *across product lines* can be largely removed if the MNC is divisionalized on the basis of geography, an area-division structure will likely cause similar problems for coordination *across geographic areas* regarding the same product. Analogous to the product-division structure, the basic weakness of the area-division structure involves the lack of a direct common boss for managers responsible for the

same product in different areas—the only common authority over them is the corporate HQ's senior management. Although inter-subsidiary competition can serve as a powerful performance incentive for managers of the same products in different countries, it can also result in actions that are highly detrimental to the firm's overall interests (Salop and Scheffman 1983). Even if rules for pricing and demarcation of sales territories become established through negotiation or intervention by the corporate HQ (both usually costly), the enforcement of such rules can be difficult due to uncertainty created by market dynamics (Chi 1994). Competition among subsidiaries can also impede the diffusion of internally generated technological improvements within the company—often essential to the sustenance of an MNC's competitive advantage. Managers may be reluctant to share their knowledge with their counterparts in potentially rivalrous subsidiaries, and attempts to transfer technology between subsidiaries may be subject to costly bargaining (Flaherty 1986, Hannaway 1989, Salop and Scheffman 1983).

In short, MNCs can potentially realize significant gains from extensive coordination both across product lines within each geographic area and across geographic areas for each product line. When coordination along both dimensions has the potential to yield large gains, a firm that remains structured along only one of these dimensions can be expected to encounter difficulty in capturing the potential gains from coordination along the other dimension. A serious organizational dilemma arises when such a company operates a unidimensional M-form structure on the basis of either product or geography. The matrix (MX-form) structure, essentially an overlay of two or more M-form structures, presents a possibility for resolving this dilemma when a firm finds it difficult to organize itself into largely self-contained operating divisions.

THE MERITS AND DEMERITS OF A MATRIX STRUCTURE

The matrix (MX-form) structure, as illustrated in Figure 1, has two or more parallel sets of organization units (e.g., divisions), with each set formulated under a different principle (e.g., product lines or geographical areas) and with each unit assigned responsibilities that overlap with those of the units of the other set(s). In a two-dimensional matrix, a subunit manager, such as an MNC's product manager at the country level, reports to two higher-level managers, such as the overseeing manager of the corresponding product division and the general manager of the MNC's operations in the particular geographic location. Although a firm may supplement its unidimensional organization design by setting up staff positions to facilitate coordination along the other dimension, a true MX-form structure differs from such variants of the M-form structure in one crucial aspect. The difference is that, under an MX-form structure, two managers situated along different dimensions of the organization and assigned overlapping responsibilities for some subunits are granted roughly equal decision-making power and evaluated in a large part on the economic outcomes of their respective units that partially coincide. Obviously, in this kind of arrangement, many issues may have to be resolved through negotiation, even though those issues potentially can also be handled on the basis of some agreed-upon rules for the division of labor between the managers with overlapping responsibilities.

Efficiency-Enhancing Attributes

The advantages of the matrix structure stem from a number of organization mechanisms that are either unavailable or costly to utilize under a unidimensional structure. First, under the matrix structure, the "budget-breaking" incentive mechanism (Harris and Raviv 1979) becomes available for activities along both dimensions of the organization.⁴ For example, a bank can often improve the overall quality of its service to large corporate customers by coordinating the

actions of its various units specialized in different types of service, such as cash management, trade financing and data processing (Zenoff and Hunter 1984). But if the gains from a joint effort have to be shared among the different units due to difficulty in mutual monitoring, each unit will necessarily receive less than 100% of its marginal contribution to the project (Chi 1996). So, if the bank manages its various service units as essentially autonomous profit centers, there will generally be some units lacking incentive to provide services that are optimal from the bank's point of view. This kind of incentive problem can often be much alleviated if the bank sets up a second layer of organization consisting of Account Managers assigned the function of overseeing the services to the bank's major corporate customers and rewarding the various service providers on the basis of their full marginal contributions. Such "budget-breaking" rewards do not have to involve a complicated payment scheme for each joint project and can simply take the form of the Account Managers' inputs in decisions on the pay raises and career advances of the individual service providers (Holmstrom 1982).

The managers in charge of coordination along each of the organizational dimensions can do much more than alleviating weak performance incentives in joint projects. One of their most important tasks involves functioning as arbiters when conflict arises between two lower-level managers. In comparison with a unidimensional structure, the proximate presence of such arbiters along both of the organizational dimensions can increase the speed of dispute resolution as well as lessen the incentives for lower-level managers to behave opportunistically in dealing with their peers. Since they can more easily uncover opportunism at lower managerial levels than could the more distant top executives, these arbiters' influences on the pay and promotion of lower-level managers should act as a more effective deterrent to those tending to engage in opportunistic behavior (Milgrom and Roberts 1990). A lower incidence of noncooperative

behavior in turn is likely to result in fewer conflicts requiring arbitration by higher-level executives.

In comparison with a unidimensional structure, a matrix organization may also be better equipped to utilize the mechanism of socialization to curb opportunism in intrafirm exchanges. Socialization refers to the process of instilling in the members of a group the pattern of behavior expected to promote the interests of the group as a whole (Feldman 1981). A key element of the socialization process in a business organization is the establishment of a psychological contract between the organization and each of its members regarding what behavior will lead to such pecuniary and nonpecuniary benefits as pay raise, promotion and job security (Baker 1985). As Kreps (1990) pointed out, the socialization process can be viewed as a repeated game in which the employer consistently allocates rewards and penalties to employees depending on whether they follow the prescribed pattern of behavior. Since behavior monitoring is inherently difficult and easily subject to errors, the ability to observe a manager from two or more organizational dimensions under a matrix structure will likely provide more accurate information for applying the appropriate rewards and penalties. In addition, many firms reportedly find job rotation and long-term career planning for upwardly mobile managers to be effective means for reducing the pursuit of parochial subunit goals that deviate from the larger organizational goals (Edstrom and Galbraith 1977, Nystrom and McArthur 1989). As job rotation can move along more than one dimension of the organization under the matrix structure, these policies may be more effective in convincing the managers that their long-term success is tied to many parts of the organization other than the subunit where they currently work.

A firm's incentive system may contain both high-powered and low-powered components, using Williamson's (1985) terminology. As illustrated by Holmstrom and Milgrom (1990, 1991,

1994), there are many situations in which high-powered incentives (such as commissions and bonuses) tend to induce behaviors (such as costly bargaining and non-cooperation) that are detrimental to the firm's overall interests. In these situations, the firm may find it optimal to put more emphasis on low-powered incentives (such as company rules and policies), despite their commonly perceived drawbacks (such as slow decision making and weak employee motivation). The potential benefit from socialization can be more efficient use of both high-powered and low-powered incentives. For instance, job rotation and long-term career planning for managers can serve as potentially effective deterrents to some of the self-serving behaviors that often result from high-powered incentives. Moreover, establishment of behavioral norms through repeated training and consistent rewards and penalties can help reduce the incidence of disputes based on self-serving interpretations of company rules and policies. Since socialization is necessarily a gradual process, an organization can not expect to derive much benefit from this mechanism until it has built up a sufficient level of socialization among its members. Given that the buildup and maintenance of socialization also entails costs, it ought to be considered a form of investment in the organization's administrative capital—similar to investment in more efficient production technology. As suggested in the preceding paragraph, the matrix structure is likely to enable an organization to achieve and maintain a working level of socialization at lower incremental costs of investment than one of the unidimensional structures.⁵

In summary, when a firm shifts from a unidimensional to a multidimensional structure, what the firm gains is primarily a reduction of intrafirm transaction costs in coordination along the previously neglected dimension. If the firm also tries to utilize organizational socialization to facilitate intrafirm transactions, the MX-form structure may be more efficient in managing the socialization process than the traditional M-form structure. The three main mechanisms that can

help reduce transaction costs in a matrix organization (i.e., budget breaking, arbitration and socialization) are all forms of quasi-centralization under which managerial control is maintained through incentive administration rather than direct centralization of decision making. In fact, as will be explained in the next subsection, intrafirm transaction costs will probably rise unduly if managers overseeing the different dimensions of the matrix attempt to centralize too many of the coordinating decisions within their respective units.

Efficiency-Debasing Attributes

A key feature of the matrix structure is that the managers of two units organized along different dimensions of the organization have overlapping jurisdictions and are both evaluated partly on the economic outcomes of their respective units that partially coincide. Because what benefits one unit may harm another unit, this arrangement could give rise to considerable conflict between units that have overlapping responsibilities. In an MNC, for instance, the manager of a product division may find it cost-saving to shift the manufacturing of some product from Korea to Mexico, but the Asian regional manager is likely to see a loss from the shift and may try to find reasons to argue against it. Since it can be difficult to ascertain whether the area division manager's reasons for objection are legitimate, the resolution of such a conflict may be rather costly. If the firm had a straight product division structure without the area dimension, the cost for resolving this kind of issue (i.e., an economically justified production shift from one country to another) would be minimal. Hence, although moving from a unidimensional structure to a matrix is likely to reduce the costs of coordination along the previously neglected dimension, it could engender frequent conflicts between managers responsible for activities along different organizational dimensions (Davis and Lawrence 1977).⁶

Moreover, because the addition of another dimension to the firm's organization structure could double the number of decision makers at the level immediately below the corporate HQ, lower-level managers typically see more decisions passed down onto them. As the decisions tend to have an impact on the well-beings of at least some of those managers, internal lobbying activities are likely to intensify as the firm shifts to a matrix structure. In the face of a marked rise in lobbying activities, the corporate HQ's senior management may feel compelled to control such activities by setting up new rules and policies, which in turn can further bureaucratize the organization and reduce decision flexibility and individual initiatives (Mintzberg 1983). As reported in some case studies, the top executives of some MNCs that moved from the traditional M-form structure to a matrix worry about "too much system that kills the entrepreneurial spirit" (Bartlett and Yoshino 1981).

The most severe drawback of the matrix structure, however, may be the degradation of performance measures due to the overlapping responsibilities of managers situated on different dimensions of the organization. Under the traditional M-form structure, each manager generally reports to only one boss, which makes authority and responsibility easily identifiable and thus allows output indicators to be fairly accurate measures of performance. However, when a manager reports to two bosses, as is typical under the MX-form structure, the noise level in output-oriented performance measures usually rises significantly at all levels below the corporate HQ. First, lower-level managers can now more easily attribute their own failures to one of their bosses by playing the bosses against each other, or try to take credit for good decisions made by one of the bosses. Being aware of the conditions conducive to such behavior, the overseeing managers may become skeptical and discount the apparent successes of their subordinates. As the causes for both successes and failures become more ambiguous, the performance incentives

for lower-level managers are likely to deteriorate. In addition, the higher-level managers that have overlapping jurisdictions under a matrix structure no longer have full control over the subunits they oversee, because these subunits are also subject to the actions of managers situated on the other dimension of the organization. This similarly makes it easier for these higher-level managers to attribute their own failures to others or to take credit for the successes of others, creating a problem for the corporate HQ's senior management who needs to evaluate their performance. Debased performance measures likely result in weakened performance incentives. In brief, although shifting to a matrix structure can improve the incentives for lower-level managers to coordinate along the previously neglected dimension, it is likely to weaken the performance incentives of managers at all levels below the corporate HQ.

COMPARISON OF A MATRIX STRUCTURE WITH ITS ALTERNATIVES

One can see more clearly the economic characteristics of the matrix (MX-form) structure by examining how the various costs of intrafirm organization likely change when a firm shifts from a unidimensional M-form structure to a two-dimensional MX-form structure. The gains from such a shift flow primarily from improved efficiency in coordination along the previously neglected dimension, whereas the losses stem primarily from problems arising out of overlapping jurisdictions of managers responsible for coordination along the different dimensions. This can be illustrated by the choice confronting an MNC among three alternative organization designs: a product-division structure, an area-division structure and a matrix structure. Under either the product-division or the area-division structure, the line of authority and responsibility goes along a single dimension, so the costs of intra-divisional coordination are low relative to the costs of inter-divisional coordination. The high costs of inter-divisional coordination in turn will cause the firm to forego many opportunities for such coordination, and therefore realize fewer benefits

from such coordination.⁷ The matrix structure represents a compromise that pays roughly equal attention to coordination along the two different dimensions but also engenders some additional transaction cost problems that could have adverse effects on coordination along both dimensions.

Table 1 summarizes the differences among the three alternative structures in terms of the benefits and costs of coordination along the two dimensions. As these benefits and costs generally can not be observed by an empirical researcher, the variables listed in the table would have to be considered latent in an empirical model. We will, nevertheless, identify some potentially observable factors that are likely to affect these benefits and costs. An example will also be provided in the latter part of the section to illustrate how these factors influenced one specific MNC's choice among the three alternative organization designs.

* * Insert Table 1 about here * *

Factors Influencing Choice Among the Three Alternative Structures

Since the main advantage of the matrix structure is more efficient coordination along the otherwise neglected dimension, the gains from shifting to a multidimensional structure, first and foremost, depend on the potential benefits from coordination along the different dimensions. By potential benefits, we mean the benefits that could be realized if coordination were frictionless, that is, if there were no transaction costs. Such economic potential from coordination necessarily depends on the nature of the firm's business. For an MNC that makes and sells a diverse range of products in a diverse array of geographic markets, one would compare (a) the benefits from coordination across geographic areas within product lines with (b) the benefits from coordination across product lines within geographic areas. Extant works on MNCs suggest that the benefits from coordination along the two dimensions depend on, respectively, the attributes of the firm's

technology and the attributes of the firm's markets (Doz 1986, Porter 1986). Firms that compete on rapid technology improvements and economies of scale (e.g., Xerox and Texas Instruments) tend to see much greater benefits from coordination within product lines than coordination within geographic areas. On the other hand, firms that compete on the ability to meet varied customer tastes and regulatory requirements across countries (e.g., P&G and Heineken) tend to see much greater benefits from coordination within geographic areas than coordination within product lines. For these two types of firms, a unidimensional structure is likely superior to a matrix structure because the matrix compromises performance measures along the crucial dimension and only produces relatively minor gains from better coordination along the other dimension. A matrix structure becomes advantageous only when there exist large potential benefits from coordination along more than one organizational dimension. Firms in the pharmaceutical and telecommunications equipment industries (e.g., Ciba-Geigy and L. M. Ericsson), for instance, face both rapid technological changes and substantial differences across markets due to differing regulations, and thus tend to see significant benefits from coordination along both dimensions.

Figure 2 summarizes how technology and market attributes may influence the choice among the three alternative organizational structures for an MNC that is diversified in terms of both products and markets.⁸ The choice would be obvious if a firm is not diversified in one of these dimensions. If the firm relies on basically the same technology to make a diverse range of products, the technology aspect of coordination could be easily performed by the corporate HQ, and the importance of coordination within each product line would be relatively small. In highly regulated industries, the impact of differing government regulations could be manifested as if there were wide differences in customer tastes across geographic areas, even though the innate preferences of consumers may be rather similar across the world.

Yet, the existence of large potential benefits from coordination along two or more dimensions of the organization constitutes a necessary but not sufficient condition for the matrix structure to be superior to its alternatives. Gainful exploitation of such benefits using a matrix structure requires that the firm be able to control the potential organization problems arising from overlapping jurisdictions between managers on the different structural dimensions (Davis and Lawrence 1977, Ford and Randolph 1992). Since the most serious problem tends to be the degradation of output-oriented performance measures, the firm should be able to avoid much of the potential difficulty if its managerial incentive system is not predominately based on output-oriented performance measures. As discussed in the last section, the mechanism of socialization can potentially foster an effective incentive system that does not heavily depend on the quality of output-oriented performance measures.

Since socialization entails repeated dispensing of rewards and penalties based on observed managerial behavior, it is necessarily a protracted process (Kreps 1990). In addition, a number of researchers have suggested that effective socialization seems to require the adoption of certain human resource management practices, such as life-time employment, regular job rotation and long-term career planning for upwardly mobile managers (Edstrom and Galbraith 1977, Nystrom and McArthur 1989). Companies that follow these practices can be expected to incur additional costs on a continuous basis. Hence, when a firm with a managerial incentive system currently based on output-oriented performance measures starts to build up the level of socialization within its organization, the firm will likely incur the cost of doing so without gaining much benefit for a considerable time. But once a sufficient level of socialization develops, the firm can expect to achieve lower costs of coordination among its decentralized units on a continuous basis. In this sense, therefore, socialization bears much resemblance to an

investment project that requires time to develop, such as a project aimed at building a flexible manufacturing system.

Firms vary considerably in the extent to which they utilize the socialization mechanism. Japanese firms purportedly rely more heavily on this mechanism to provide managerial incentives than do U.S. firms (Hennart 1991, Ouchi 1980). So, if a firm has already built up a high level of socialization among its managers, shifting from the traditional M-form structure to the MX-form structure is unlikely to engender much organizational difficulty. However, if a firm currently relies heavily on output-oriented performance measures to provide managerial incentives, shifting to a matrix will likely bring about significant losses in organizational efficiency, at least immediately after the shift. Meanwhile, as suggested earlier, a matrix structure may also be more conducive than a unidimensional structure to the buildup of socialization within the organization. From a dynamic perspective, therefore, a firm that foresees large potential benefits from coordination along two or more dimensions may still find it optimal to switch to the matrix structure and in the meantime deliberately invest in its administrative capital of socialization. Although we are not aware of any large-sample empirical study on how the adoption of the matrix structure relates to the use of the socialization mechanism, a number of case studies suggest some correlation between these two organizational phenomena (Doz 1983, Simons and Bartlett 1992). Specifically, MNCs that start investing heavily in socialization at the time of adopting a matrix structure tend to keep this form of organization, whereas other MNCs that do not make much use of socialization tend to abandon the matrix structure after a period of experimentation.

Finally, it should be pointed out that there also exist mechanisms that can lower the costs of coordination along more than one dimension without shifting to a matrix structure. Research

in game theory has shown that the incentive for behaving cooperatively tends to increase as the transacting parties foresee greater opportunities for mutually beneficial collaboration in the future (Radner 1986, Telser 1980).⁹ This idea suggests that the expectation of large mutual gains from continued collaboration among the various units and subunits of the firm may be able to sustain coordination along more than one dimension without the adoption of a matrix organization. In fact, according to the field study of Bartlett and Ghoshal (1989), some large MNCs deliberately create and maintain a high level of technological interdependence among their subsidiaries in different countries to create incentives for the subsidiary managers to coordinate by themselves without any central intervention. These MNCs typically create such interdependence by encouraging and helping each subsidiary develop technological expertise in a specific area so that other subsidiaries see benefits from continued collaboration with it. The availability of this type of organization mechanism has the effect of lessening the advantage of the MX-form structure over the straight M-form structure in exploiting potential benefits from coordination along more than one dimension.

An Example

In the rest of this section, we will examine how the organization structure of a specific MNC evolved as it expanded in terms of both products offered and geographic markets served and as a result experienced growing interdependence among the various parts of the company. The discussion is based on a series of case studies by Bartlett and Yoshino (1981) on Corning Glass Works (CGW).

Established in 1851, CGW first started exporting specialty glassware from its US base in 1918 when it only had a limited line of products. For a long time, its business involvement in other countries was primarily in the form of export and technology licensing. While its domestic

side of business was organized into several product divisions, its international side of business was managed by an international division structured on a geographic basis. But with a change of leadership in the 1960s, the company adopted a more aggressive expansion strategy through acquisition of its foreign competitors, licensees and joint venture partners. This strategy not only quickly increased its geographic coverage and depth of international involvement but also further broadened its product lines because the acquisition of foreign firms often brought in new product lines. By the mid 1970s, CGW had developed into a large MNC with over \$1 billion in sales of a diverse range of products based on various specialty glass materials or components made of such materials. It had six product groups with substantial foreign operations; these were *Electronics*, *Medical*, *Consumer*, *Science*, *Television* and *Ophthalmic*.¹⁰ The characteristics of the six product groups are described briefly in the Appendix.

In the mid 1970s, CGW began to realize that it was forgoing potentially substantial gains from closer coordination among many parts of the company that were currently organized as largely autonomous units. This was primarily due to the fact that its foreign subsidiaries were set up as highly independent entities managerially separate from its domestic units, even though they often produced the same products and sold in the same markets. There were no mechanisms for disseminating technological innovation, optimizing capacity utilization or demarcating sales territories. In an attempt to address these perceived inefficiencies, CGW installed six additional managers at the vice-president level in its international division to coordinate activities in each of the six product groups and act as liaisons with the corresponding domestic product divisions. This attempt largely failed to yield the anticipated results, primarily because higher CGW executives were reluctant to spell out in detail the responsibilities and authorities of those coordinators due to the large variation in the attributes of the six businesses (see the Appendix).

As a result, some of these new coordinators were viewed as intervening excessively in matters that should be left to local managers, and most were unable to have much influence on the decisions of local managers who were still evaluated almost exclusively on the operating outcomes of their respective subunits.

Based on the lessons learnt from this failed effort and on the advice from a consulting firm, CGW undertook a major reorganization. The six product groups were each organized in a form of matrix with differing emphases on the product and geographic dimensions depending on their business characteristics (see the Appendix). The product dimension was given greater influence on decisions in the *Electronics* and *Medical* groups, due to the greater importance of production coordination in these two businesses. The geographic dimension was given greater influence in the *Consumer* and *Science* groups, due to the greater importance of marketing coordination in these two businesses. The two dimensions were given roughly equal influence in the *Television* and *Ophthalmic* groups, due to the importance of both production and marketing coordination in these two businesses. The relative influences of managers situated along the two dimensions of the organization were clarified through a series of meetings that first identified the key decisions and then built a consensus on what role each manager should play in each of the key decisions. A manager's role in a given decision could be, for instance, recommending a solution, concurring with the solution recommended by another manager, or making the final decision independently.

The matrix structure that CGW adopted in the mid 1970s remained controversial within the company.¹¹ Although CGW was able to effect some highly beneficial coordination along the previously neglected product dimension in its international operations, it also encountered many of the problems associated with dual responsibility under the matrix structure. After five years of

experimentation, the company decided to keep the matrix structure only in the *Television* and *Ophthalmic* businesses and abandon the dual responsibility system for the rest of the company. The *Electronics* and *Medical* businesses were reorganized strictly based on product lines, and the *Consumer* and *Science* businesses were reorganized strictly based on geographic areas. All of these reorganization decisions appear to be consistent with predictions derivable from Figure 2.

CONCLUSION

Under the conventional M-form structure, the basic principle of organization involves structuring the firm into essentially self-contained units such as divisions that handle different product lines. In the last two decades, however, many firms have encountered increasing difficulty in keeping their operating divisions as largely self-contained units as their growth and expansion has created very complex interdependencies among the various units and subunits of the organization. Such interdependencies are generally manifested as the presence of sizable potential gains from close coordination among the various units and subunits along more than one dimension (e.g., across product lines in each geographic area and across geographic areas for each product line). The M-form structure inherently makes it difficult for a firm to maintain frequent and close coordination of its activities along more than one dimension.

The MX-form structure has been regarded by some as an organizational innovation conceived to facilitate coordination along two or more dimensions. By having lower-level managers report to two or more bosses overseeing the different dimensions of the organization, the matrix structure can potentially lessen the costs of coordination along the otherwise neglected dimension(s). In the meantime, the overlapping of responsibilities between managers overseeing the different dimensions also can create or worsen certain transaction cost problems and adversely affect the overall organizational efficiency in the company. Consequently, for many

companies, the expected gains from better coordination along the otherwise neglected dimension may not outweigh the expected losses from the establishment of overlapping managerial jurisdictions. In general, two conditions can make the MX-form structure compare more favorably with the basic M-form structure: (a) the presence of large potential benefits from close coordination along more than one dimension of the organization and (b) the buildup by the adopting firm of its administrative capital of socialization. A firm probably will be unable to realize a net gain from adopting a matrix structure in the absence of one or both of these conditions. While the matrix structure is rather widely used among MNCs, many firms that are not multinational have also adopted this organizational form. We earlier provided an example of how the matrix form works in a bank. Engineering firms also often utilize a matrix form, structured along both projects and engineering functions (Barker *et al.* 1988, Kerzner 1989).

Although the MX-form structure may seem to be a natural evolution from the basic M-form structure, the balance of organization mechanisms utilized by the MX-form structure actually bears considerable similarity to that of the M-form's predecessor—the U-form structure (Child and Kieser 1981, Jerkovsky 1983). The shift from the U-form to the M-form structure involves a change in the balance from input-oriented incentives toward output-oriented incentives; the change from the M-form to the MX-form structure, however, generally moves in the reverse direction. As suggested in the last section, by creating the condition of mutual gains from intrafirm collaboration, some firms also seem to have made significant progress in increasing the efficiency of coordination along more than one dimension without adopting a matrix form of organization. Given the controversy surrounding the matrix structure, and its frequently reported failures, we think it remains premature to judge whether the matrix structure represents a major organizational innovation.

APPENDIX

This appendix gives a brief description of the six multinational product groups that Corning Glass Works had in the mid to late 1970s.¹² As stated in the main text, the six groups were *Electronics*, *Medical*, *Consumer*, *Science*, *Television* and *Ophthalmic*.

The *Electronics* products included various electronic components such as resistors and capacitors and were mainly sold to large multinational manufacturers of electronic equipment. The technology for those products was changing at the time, and substantial development effort was needed to keep up with the change; in addition, their production also exhibited significant economies of scale. The *Medical* products were mainly diagnostic instruments for testing body chemistry. These products had short life cycles and required heavy investment in R&D to stay competitive, but their customers across the world demanded essentially the same features so long as the power supplies were adapted to local requirements. As can be seen, the attributes of the *Electronics* and *Medical* products would place them in the lower-left cell of Figure 2.

The *Consumer* products consisted of special glass cookware and tableware and flattop glass ceramic cook surfaces. Technological change in this business was slow, and the infrequent innovations generally were effectively protected by patents. However, the shapes and designs of those products varied considerably from country to country due to differing cooking practices; so did the distribution systems for the products. The *Science* products fall in two main areas: special lab glassware and process systems for scientific research. Most of the lab glassware was standardized and based on the same type of glass material as used in the oven-to-table cookware, but the distribution channels were different from those for cookware and also varied widely from country to country. The process systems (such as glass piping) typically had to be designed for the specific applications of customers. In addition, the cookware and labware products also had a

low value-to-weight ratio, making it economical to manufacture them locally for local customers.

The attributes of the *Consumer* and *Science* products, therefore, would place them in the upper-right cell of Figure 2.

The *Television* products involved picture tubes custom-engineered for large multinational TV set manufacturers whose production facilities were typically set up on a regional basis to accommodate differing TV transmission standards. CGW's TV bulb production was also spread across the different regions of the world, and each region had to coordinate with its customers closely to satisfy their requirements for fine-tuning and product differentiation. Although the technology was mature, innovations for quality improvement and cost saving were constant. The *Ophthalmic* products were principally eye glass blanks made of different glass materials and produced to a variety of thickness, curvature and periphery specifications. Their high value-to-weight ratio made it very economical to manufacture them in a small number of large plants and supply the world markets through export. In addition, the variety of product specifications made sourcing complex and subject to significant gains from close coordination among the plants located in different parts of the world. In the meantime, the complexity of product specifications also made it important to be sensitive to the needs of local customers in the face of competition from other suppliers. The importance of both production and marketing coordination in the *Television* and *Ophthalmic* businesses would place them in the lower-right cell of Figure 2.

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NOTES

¹ Williamson and Bhargava (1972) provide a scheme for classifying organizational forms, largely based on the distinction between the unitary (U-form) structure and the multidivisional (M-form) structure. Their scheme does include, however, a mixed (X-form) category to cover structures that can not be classified as either of these forms or any of their variants. Presumably, a matrix (MX-form) structure would fall into the X-form under their scheme.

² The expansion of a firm can involve the acquisition or development of additional product lines, or the entry into additional geographic markets. Our discussion in this section focuses on the geographic expansion of multi-product firms.

³ Staff jobs are performed by specialists who provide “expert advice and service” to line managers, but the line managers retain responsibility for decisions (Gailbraith 1977: 18)

⁴ Our analysis in the rest of the paper will assume a two-dimensional matrix for expositional ease. The principles discussed here, nevertheless, apply to matrices of higher dimensions as well.

⁵ Note that we are not suggesting that the matrix structure is always a more economical form of organization for firms that try to invest in the administrative capital of socialization. As will be explained later in the paper, for a given firm, the aggregate costs of organization under the matrix structure could be significantly higher than under one of unidimensional structures, with or without any attempt at socialization.

⁶ It should be pointed out here that many of such conflicts may result in better decisions for the company as a whole due to more attention given to coordination along the previously neglected dimension. So, for a company that can obtain large benefits from coordination along more than one dimension, the gains from improved overall coordination may exceed the losses from conflicts arising out of managers with overlapping jurisdictions pursuing parochial objectives.

⁷ It is useful to distinguish between potential and realizable benefits from coordination along a given dimension of the organization. As will be explained in the next paragraph, the size of the potential benefit depends on the nature of the firm’s business. But given the nature of the firm’s business, the realizable benefit from coordination along each dimension is a function of the chosen organization structure, because the firm may forego certain coordinative activities when the chosen structure makes it too costly to pursue those activities.

⁸ The results shown in Figure 2 are to a large extent due to the insightful comments and suggestions of an anonymous referee.

⁹ Recent analysis of cooperative behavior has put much emphasis on the notion of trust. But as Williamson (1993) pointed out, trust would have no rational basis unless it is supported by the expectation of mutual gains for the collaborators.

¹⁰ Two other product groups, *Refractories* and *Lighting*, did not have significant international involvement.

¹¹ Strictly speaking, CGW still had a multidivisional (M-form) structure and only used the matrix (MX-form) structure at a lower level of organization (i.e., within each of the six product groups). The firm’s experience with the matrix form of organization, however, provides a good example to illustrate some of the ideas developed in this paper.

¹² Greater details about the company and its organizational evolution up to the late 1970s can be found in Bartlett and Yoshino (1981).

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Table 1: Comparison of Three Alternative Structures for a Given Multinational Corporation ^{a, b}

Type of Coordination		Product-Division Structure		Matrix Structure	Area-Division Structure	
Across geographic areas concerning the same product line	Benefits ^c	B_P^P	\geq	B_X^P	\geq	B_A^P
	Costs	C_P^P	\leq	C_X^P	\leq	C_A^P
	Net Gains	$G_P^P = B_P^P - C_P^P$	\geq	$G_X^P = B_X^P - C_X^P$	\geq	$G_A^P = B_A^P - C_A^P$
Across product lines within the same geographic area	Benefits ^c	B_P^A	\leq	B_X^A	\leq	B_A^A
	Costs	C_P^A	\geq	C_X^A	\geq	C_A^A
	Net Gains	$G_P^A = B_P^A - C_P^A$	\leq	$G_X^A = B_X^A - C_X^A$	\leq	$G_A^A = B_A^A - C_A^A$
Total Gains		$G_P = G_P^P + G_P^A$		$G_X = G_X^P + G_X^A$		$G_A = G_A^P + G_A^A$

^a Superscripts denote the type of coordination, with
 P = intra-product coordination across geographic areas
 A = intra-area coordination across product lines

^b Subscripts denote the organization structure, with
 P = product-division structure
 A = area-division structure
 X = matrix structure

^c The benefit with which this table is concerned is the extent of the potential benefit that can be realized under each organization structure, given the nature of the MNC's business and hence the potential benefit from coordination along each of the two dimensions.

Figure 1: Illustration of a Multinational Corporation's Matrix Structure

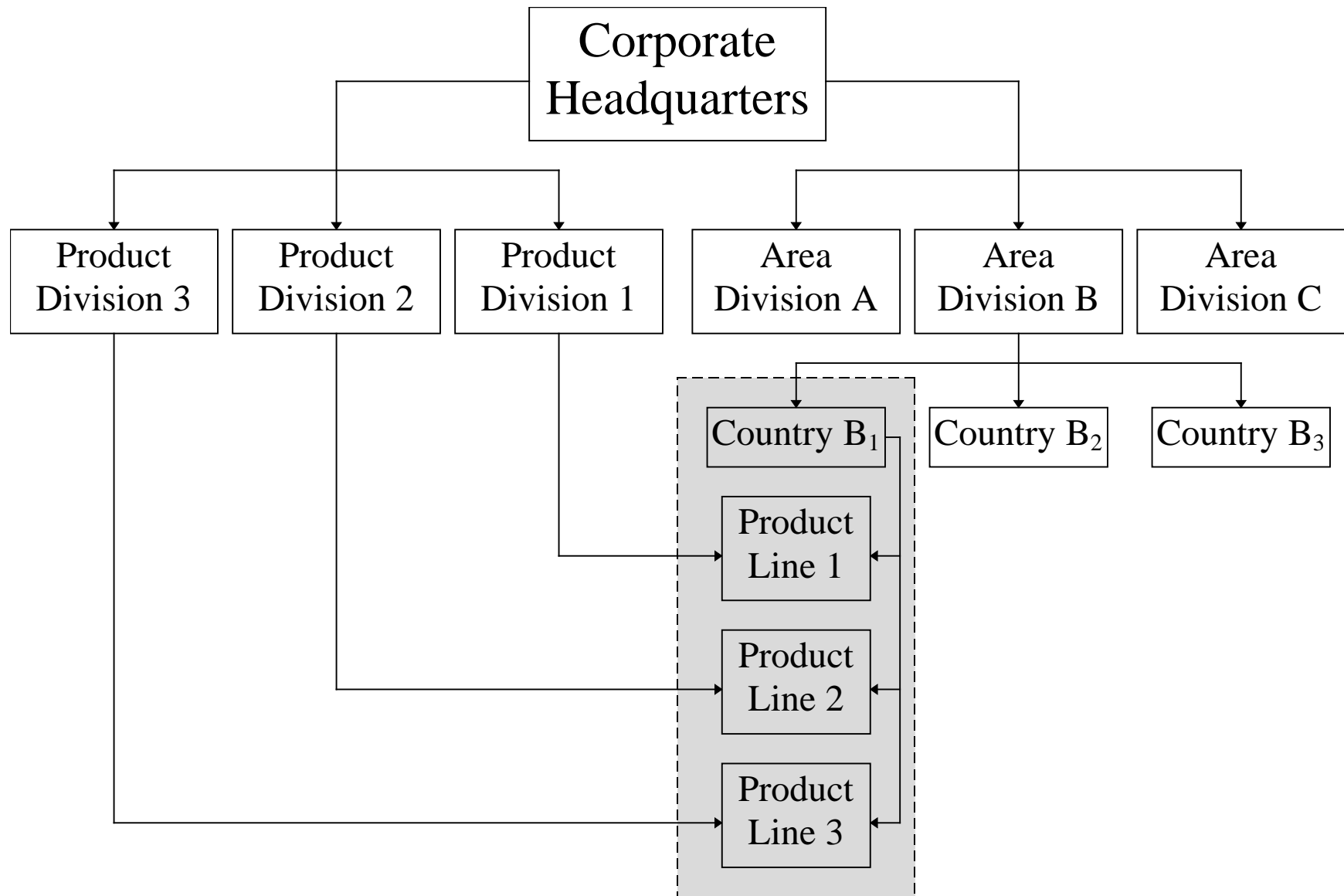


Figure 2: Key Determinants of a Multinational Corporation's Organizational Choice ^a

		Variation of Customer Tastes and Regulatory Requirements Across Geographic Areas	
		Small	Large
Technological Diversity Across Product Lines and Speed of Technological Change	Low		Area-Based M-Form
	High	Product-Based M-Form	Matrix MX-form

^a The Multinational Corporation is assumed to make and market a diverse range of products in a diverse array of geographic markets.